

Claims

We Claim:

1 1. A method of designing an electrical wiring structure having a plurality of wires, said method
2 comprising identifying at least one wire pair, said wire pair including a first wire of the plurality
3 of wires and a second wire of the plurality of wires, said second wire already tri-stated or can be
4 tri-stated, said wire pair having a same-direction switching probability ϕ_{SD} per clock cycle that is
5 no less than a pre-selected minimum same-direction switching probability $\phi_{SD,MIN}$ or having an
6 opposite-direction switching probability ϕ_{OD} per clock cycle that is no less than a pre-selected
7 minimum opposite-direction switching probability $\phi_{OD,MIN}$, said first wire and said second wire
8 satisfying at least one mathematical relationship, said at least one mathematical relationship
9 involving L_{COMMON} and $W_{SPACING}$, said $W_{SPACING}$ defined as a spacing between the first wire and
10 the second wire, said L_{COMMON} defined as a common run length of the first wire and the second
11 wire.

1 2. The method of claim 1, said at least one mathematical relationship comprising:

2 $W_{SPACING}$ no greater than a pre-selected minimum spacing $W_{SPACING, MAX}$; and

3 L_{COMMON} no less than a pre-selected minimum common run length $L_{COMMON, MIN}$.

1 3. The method of claim 1, said at least one mathematical relationship comprising $F_{LW} \geq F_{LW,MIN}$,
2 said F_{LW} defined as $L_{COMMON}/W_{SPACING}$, said $F_{LW,MIN}$ defined as a pre-selected minimum value of
3 F_{LW} .

1 4. The method of claim 1, wherein identifying at least one wire pair comprises:
2 identifying at least one high-power wire; and
3 for a high-power wire of the at least one high-power wire, identifying a good neighbor
4 wire of the high-power wire, wherein the first wire of the wire pair is the high-power wire, and
5 wherein the second wire of the wire pair is the good neighbor wire.

1 5. The method of claim 1, wherein said second wire is not already tri-stated but can be tri-stated,
2 and further comprising adding tri-stating logic to the second wire.

1 6. The method of claim 1, wherein ϕ_{OD} is no less than $\phi_{OD,MIN}$, and further comprising adding
2 logic for inverting the second wire along the common run length.

1 7. The method of claim 1, further comprising adding blocking logic for blocking propagation of a
2 signal from the second wire while the second wire is tri-stated.

1 8. The method of claim 1, further comprising reducing W_{SPACING} .

1 9. The method of claim 1, wherein the at least one wire pair includes a plurality of wire pairs, and
2 further comprising:

3 ranking the wire pairs in accordance with power dissipation savings;

4 developing a list of the ranked wire pairs in sorted order of the power dissipation savings;

5 and

6 truncating the list at a point of diminishing returns in the power dissipation savings, in
7 accordance with a predetermined truncation criterion.

1 10. The method of claim 1, wherein W_{SPACING} is a predetermined spacing, and wherein L_{COMMON} is
2 a predetermined common run length.

1 11. The method of claim 1, wherein W_{SPACING} is an established spacing, and wherein L_{COMMON} is
2 an established common run length.

1 12. A method for executing a two-wire voltage transition, comprising the steps of:
2 providing two wires of an electrical wire network, said two wires denoted as an A wire
3 and a B wire, said A wire having a capacitance C_A , said B wire having a capacitance C_B , said A
4 wire and B wire having a coupling capacitance C_C between the A wire and the B wire;
5 tri-stating the B wire from a voltage V_{B1} to a high impedance state;
6 after tri-stating the B wire, transitioning the A wire from a voltage V_{A1} to a voltage V_{A2}
7 such that $V_{A2} \neq V_{A1}$; and
8 after transitioning the A wire to V_{A2} , transitioning the B wire to a voltage V_{B2} such that
9 $V_{B2} \neq V_{B1}$.

10 13. The method of claim 12, wherein $(V_{A2} - V_{A1})(V_{B2} - V_{B1}) > 0$.

11 14. The method of claim 13, wherein the A wire and the B wire have a same-direction switching
12 probability per clock cycle ϕ_{SD} that is no less than a pre-selected minimum same-direction
13 switching probability $\phi_{SD,MIN}$.

1 15. The method of claim 13, wherein $V_{A1} = V_{B1} = 0$ and $V_{A2} = V_{B2} = 1$, and wherein an effective
2 capacitance of the two-wire voltage transition is $C_A + C_B$.

1 16. The method of claim 13, wherein $V_{A1} = V_{B1} = 1$ and $V_{A2} = V_{B2} = 0$, and wherein an effective
2 capacitance of the two-wire voltage transition is 0.

1 17. The method of claim 12, wherein $(V_{B2} - V_{B1})(V_{A2} - V_{A1}) < 0$, wherein the A wire and the B wire
2 have a common run length, and further comprising inverting the B wire along the common run
3 length.

1 18. The method of claim 17, wherein the A wire and the B wire have an opposite-direction
2 switching probability per clock cycle ϕ_{OD} that is no less than a pre-selected minimum opposite-
3 direction switching probability $\phi_{OD,MIN}$.

1 19. The method of claim 17, wherein $V_{A1} = 0$, $V_{B1} = 1$, $V_{A2} = 1$, and $V_{B2} = 0$, and wherein an
2 effective capacitance of the two-wire voltage transition is $C_A + C_B$.

1 20. The method of claim 17, wherein $V_{A1} = 1$, $V_{B1} = 0$, $V_{A2} = 0$, and $V_{B2} = 1$, and wherein an
2 effective capacitance of the two-wire voltage transition is 0.

1 21. The method of claim 12, further comprising blocking propagation of a signal from the B wire
2 while the B wire is tri-stated.

1 22. An electrical wiring structure, comprising at least one wire pair, said wire pair including a
2 first wire and a second wire, said second wire slated for being tri-stated, said wire pair having a
3 same-direction switching probability ϕ_{SD} per clock cycle that is no less than a pre-selected
4 minimum same-direction switching probability $\phi_{SD,MIN}$ or having an opposite-direction switching
5 probability ϕ_{OD} per clock cycle that is no less than a pre-selected minimum opposite-direction
6 switching probability $\phi_{OD,MIN}$, said first wire and said second wire satisfying at least one
7 mathematical relationship, said at least one mathematical relationship involving L_{COMMON} and
8 $W_{SPACING}$, said $W_{SPACING}$ defined as a spacing between the first wire and the second wire, said
9 L_{COMMON} defined as a common run length of the first wire and the second wire.

10 23. The electrical wiring design of claim 22, said at least one mathematical relationship
11 comprising:

12 $W_{SPACING}$ no greater than a pre-selected minimum spacing $W_{SPACING,MAX}$; and

13 L_{COMMON} no less than a pre-selected minimum common run length $L_{COMMON,MIN}$.

1 24. The electrical wiring design of claim 22, said at least one mathematical relationship
2 comprising $F_{LW} \geq F_{LW,MIN}$, said F_{LW} defined as $L_{COMMON}/W_{SPACING}$, said $F_{LW,MIN}$ defined as a pre-
3 selected minimum value of F_{LW} .

1 25. The electrical wiring design of claim 22, wherein the first wire of the wire pair is a high-
2 power wire, and wherein the second wire of the wire pair is a good neighbor wire of the high

3 power wire.

1 26. The electrical wiring design of claim 22, wherein ϕ_{OD} is no less than $\phi_{OD,MIN}$, and further
2 comprising logic for inverting the second wire along the common run length.

1 27. The electrical wiring design of claim 22, further comprising blocking logic for blocking
2 propagation of a signal from the second wire while the second wire is tri-stated.

1 28. The electrical wiring design of claim 22, wherein $W_{SPACING}$ is a predetermined spacing, and
2 wherein L_{COMMON} is a predetermined common run length.

1 29. The electrical wiring design of claim 22, wherein $W_{SPACING}$ is an established spacing, and
2 wherein L_{COMMON} is an established common run length.

1 30. An electrical wire structure, comprising two wires of a wire network, said two wires denoted
2 as an A wire and a B wire, said A wire having a capacitance C_A , said B wire having a capacitance
3 C_B , said A wire and B wire having a coupling capacitance C_C between the A wire and the B wire,
4 said B wire in a tri-state, said A wire transitioning from a voltage V_{A1} to a voltage V_{A2} such that
5 $V_{A2} \neq V_{A1}$, said B wire having transitioned to the tri-state from a voltage V_{B1} , said B wire
6 intended to be transitioned to a voltage V_{B2} such that $V_{B2} \neq V_{B1}$ after the A wire has transitioned
7 to the voltage V_{A2} , said transition of the A wire from the voltage V_{A1} to the voltage V_{A2} and of the
8 B wire from the voltage V_{B1} to the voltage V_{B2} identified as a two-wire voltage transition.

1 31. The electrical wire network of claim 30, wherein $(V_{A2} - V_{A1})(V_{B2} - V_{B1}) > 0$.

1 32. The electrical wire network of claim 31, wherein the A wire and the B wire have a same-
2 direction switching probability per clock cycle ϕ_{SD} that is no less than a pre-selected minimum
3 same-direction switching probability $\phi_{SD,MIN}$.

1 33. The electrical wire network of claim 31, wherein $V_{A1} = V_{B1} = 0$ and $V_{A2} = V_{B2} = 1$, and
2 wherein an effective capacitance of the two-wire voltage transition is $C_A + C_B$.

1 34. The electrical wire network of claim 31, wherein $V_{A1} = V_{B1} = 1$ and $V_{A2} = V_{B2} = 0$, and
2 wherein an effective capacitance of the two-wire voltage transition is 0.

1 35. The electrical wire network of claim 30, wherein $(V_{B2} - V_{B1})(V_{A2} - V_{A1}) < 0$, wherein the A wire
2 and the B wire have a common run length, and further comprising the B wire inverted along the
3 common run length.

1 36. The electrical wire network of claim 35, wherein the A wire and the B wire have an opposite-
2 direction switching probability per clock cycle ϕ_{OD} that is no less than a pre-selected minimum
3 opposite-direction switching probability $\phi_{OD,MIN}$.

1 37. The electrical wire network of claim 35, wherein $V_{A1} = 0$, $V_{B1} = 1$, $V_{A2} = 1$, and $V_{B2} = 0$, and
2 wherein an effective capacitance of the two-wire voltage transition is $C_A + C_B$.

1 38. The electrical wire network of claim 35, wherein $V_{A1} = 1$, $V_{B1} = 0$, $V_{A2} = 0$, and $V_{B2} = 1$, and
2 wherein an effective capacitance of the two-wire voltage transition is 0.

1 39. The electrical wire network of claim 30, wherein propagation of a signal from the B wire
2 while the B wire is being blocked.

1 40. A computer system for designing an electrical wiring structure having a plurality of wires,
2 comprising:
3 a processor;
4 an input device coupled to the processor;
5 an output device coupled to the processor;
6 a first memory device coupled to the processor;
7 a second memory device coupled to the processor;
8 a computer code stored in the second memory device and executed by the processor; said
9 computer code comprising an algorithm, said algorithm identifying at least one wire pair, said
10 wire pair including a first wire of the plurality of wires and a second wire of the plurality of
11 wires, said second wire already tri-stated or can be tri-stated, said wire pair having a same-
12 direction switching probability ϕ_{SD} per clock cycle that is no less than a pre-selected minimum
13 same-direction switching probability $\phi_{SD,MIN}$ or having an opposite-direction switching
14 probability ϕ_{OD} per clock cycle that is no less than a pre-selected minimum opposite-direction
15 switching probability $\phi_{OD,MIN}$, said first wire and said second wire satisfying at least one
16 mathematical relationship, said at least one mathematical relationship involving L_{COMMON} and
17 $W_{SPACING}$, said $W_{SPACING}$ defined as a spacing between the first wire and the second wire, said
18 L_{COMMON} defined as a common run length of the first wire and the second wire.

1 41. The computer system of claim 40, said at least one mathematical relationship comprising:

2 $W_{SPACING}$ no greater than a pre-selected minimum spacing $W_{SPACING, MAX}$; and

3 L_{COMMON} no less than a pre-selected minimum common run length $L_{\text{COMMON, MIN}}$.

1 42. The computer system of claim 40, said at least one mathematical relationship comprising F_{LW}
2 $\geq F_{\text{LW, MIN}}$, said F_{LW} defined as $L_{\text{COMMON}}/W_{\text{SPACING}}$, said $F_{\text{LW, MIN}}$ defined as a pre-selected minimum
3 value of F_{LW} .

1 43. The computer system of claim 40, wherein said algorithm identifying at least one wire pair
2 includes:

3 said algorithm identifying at least one high-power wire; and

4 for a high-power wire of the at least one high-power wire, said algorithm identifying a
5 good neighbor wire of the high-power wire, wherein the first wire of the wire pair is the high-
6 power wire, and wherein the second wire of the wire pair is the good neighbor wire.

1 44. The computer system of claim 40, wherein if said algorithm determines that said second wire
2 is not already tri-stated but can be tri-stated, then further comprising said algorithm adding tri-
3 stating logic to the second wire.

1 45. The computer system of claim 40, wherein if said algorithm determines that ϕ_{OD} is no less
2 than $\phi_{\text{OD, MIN}}$, then further comprising said algorithm adding logic for inverting the second wire
3 along the common run length.

1 46. The computer system of claim 40, further comprising the computer algorithm adding
2 blocking logic for blocking propagation of a signal from the second wire while the second wire is
3 tri-stated.

1 47. The computer system of claim 40, further comprising the computer algorithm reducing
2 W_{SPACING} .

1 48. The computer system of claim 40, wherein if said the computer algorithm identifies the at
2 least one wire pair as including a plurality of wire pairs, then further comprising:

3 said computer algorithm ranking the wire pairs in accordance with power dissipation
4 savings;

5 said computer algorithm developing a list of the ranked wire pairs in sorted order of the
6 power dissipation savings; and

7 said computer algorithm truncating the list at a point of diminishing returns in the power
8 dissipation savings, in accordance with a predetermined truncation criterion.

1 49. The computer system of claim 40, wherein W_{SPACING} is a predetermined spacing, and wherein
2 L_{COMMON} is a predetermined common run length.

1 50. The computer system of claim 40, wherein W_{SPACING} is an established spacing, and wherein
2 L_{COMMON} is an established common run length.

1 51. A computer program product, comprising: a computer usable medium having a computer
2 readable program code embodied therein for designing an electrical wiring structure having a
3 plurality of wires, wherein the computer readable program code includes an algorithm, said
4 algorithm identifying at least one wire pair, said wire pair including a first wire of the plurality of
5 wires and a second wire of the plurality of wires, said second wire already tri-stated or can be tri-
6 stated, said wire pair having a same-direction switching probability ϕ_{SD} per clock cycle that is no
7 less than a pre-selected minimum same-direction switching probability $\phi_{SD,MIN}$ or having an
8 opposite-direction switching probability ϕ_{OD} per clock cycle that is no less than a pre-selected
9 minimum opposite-direction switching probability $\phi_{OD,MIN}$, said first wire and said second wire
10 satisfying at least one mathematical relationship, said at least one mathematical relationship
11 involving L_{COMMON} and $W_{SPACING}$, said $W_{SPACING}$ defined as a spacing between the first wire and
12 the second wire, said L_{COMMON} defined as a common run length of the first wire and the second
13 wire.

52. The computer program product of claim 51, said at least one mathematical relationship
comprising:

$W_{SPACING}$ no greater than a pre-selected minimum spacing $W_{SPACING, MAX}$; and

L_{COMMON} no less than a pre-selected minimum common run length $L_{COMMON, MIN}$.

1 53. The computer program product of claim 51, said at least one mathematical relationship
2 comprising $F_{LW} \geq F_{LW,MIN}$, said F_{LW} defined as $L_{COMMON}/W_{SPACING}$, said $F_{LW,MIN}$ defined as a pre-

1 selected minimum value of F_{LW} .

1 54. The computer program product of claim 51, wherein said algorithm identifying at least one
2 wire pair includes:

3 said algorithm identifying at least one high-power wire; and

4 for a high-power wire of the at least one high-power wire, said algorithm identifying a
5 good neighbor wire of the high-power wire, wherein the first wire of the wire pair is the high-
6 power wire, and wherein the second wire of the wire pair is the good neighbor wire.

1 55. The computer program product of claim 51, wherein if said algorithm determines that said
2 second wire is not already tri-stated but can be tri-stated, then further comprising said algorithm
3 adding tri-stating logic to the second wire.

1 56. The computer program product of claim 51, wherein if said algorithm determines that ϕ_{OD} is
2 no less than $\phi_{OD,MIN}$, then further comprising said algorithm adding logic for inverting the second
3 wire along the common run length.

1 57. The computer program product of claim 51, further comprising the computer algorithm
2 adding blocking logic for blocking propagation of a signal from the second wire while the second
3 wire is tri-stated.

1 58. The computer program product of claim 51, further comprising the computer algorithm
2 reducing W_{SPACING} .

1 59. The computer program product of claim 51, wherein if said the computer algorithm identifies
2 the at least one wire pair as including a plurality of wire pairs, then further comprising:

3 said computer algorithm ranking the wire pairs in accordance with power dissipation
4 savings;

5 said computer algorithm developing a list of the ranked wire pairs in sorted order of the
6 power dissipation savings; and

7 said computer algorithm truncating the list at a point of diminishing returns in the power
8 dissipation savings, in accordance with a predetermined truncation criterion.

1 60. The computer program product of claim 51, wherein W_{SPACING} is a predetermined spacing,
2 and wherein L_{COMMON} is a predetermined common run length.

1 61. The computer program product of claim 51, wherein W_{SPACING} is an established spacing, and
wherein L_{COMMON} is an established common run length.